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12MTP14

First Semester M.Tech. Degree Examination, February 2013
Thermodynamics and Combustion Engineering

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Use of thermodynamic data book is permitted.

1 a. Define the work is thermodynamics point of view. Is it possible that $W \neq 0$ even if $dv = 0$? If so give an example. **(06 Marks)**

b. Clearly write the steady flow energy equation for an open system and explain the terms involved. Given a change, how would you modify the same to suit (i) Turbine, (ii) Steam nozzle, (iii) Boiler. **(06 Marks)**

c. During a certain expansion process of a perfect gas, the variation in pressure is estimated to conform to the linear relation $p = aV + b$, where a and b are constants and V represents the volume in m^3. The gas has a mass of 0.75 kg, the initial and final pressures are 4 bar and 2 bar, and the corresponding volumes are 0.1 m^3 and 0.2 m^3. Make calculation for the work and heat interaction during the process. Comment on the nature of process. **(08 Marks)**

2 a. Define heat engine and a heat pump and show that $(COP)_{HP} = 1 + (COP)_R$, where HP stands for heat pump and R stands for a refrigerator. **(06 Marks)**

b. 5 kg of water at 30°C is mixed with 1 kg of ice at 0°C. The process of mixing in adiabatic and the system is open to atmosphere. Make calculations for the temperature of mixture and the change of entropy for the spontaneous mixing process. Take C_p of water = 4.187 kJ/kgK and latent heat of ice = 335 kJ/kg. **(06 Marks)**

c. One inventor claims that when 2 kg of air is supplied to a magic tube at 4 bar and 20°C, two equal mass streams at 1 bar are produced; one at –20°C and the other at 80°C. Another inventor claims that it is possible to produce two equal mass streams. One at – 40°C and the other at 40°C. Considering the system to be adiabatic, determine which claim is correct and why? Assume ambient condition at 0°C. **(08 Marks)**

3 a. What do you mean by available and unavailable energy? Derive an expression for availability of a steady flow open system. **(10 Marks)**

b. A system at 450 K receives 225 kJ/s of heat energy from a source at 1500 K and the temperatures of both the system and source remain constant during the heat transfer process. Represent the process on temperature-entropy diagram and determine
i) net change in entropy
ii) available energy of heat sources and system
iii) decrease in available energy
Take atmospheric temperature equal to 300 K. **(10 Marks)**

4 a. What is pure substance? Distinguish between critical point and triple point. **(04 Marks)**

b. Two boilers A and B discharges equal amount of steam into a common steam pipe. The steam being supplied by boiler A is at 10 bar pressure and 350°C temperature. The steam from boiler B is at the same pressure but is wet with dryness fraction 0.92. Determine: (i) equilibrium condition after mixing in the common steam pipe. (ii) change in entropy of the steam from boilers A and B (iii) net increase or decrease of entropy. **(10 Marks)**

c. State Dalton's law of partial pressures and hence derive an expression for the gas constant of a mixture of ideal gases. **(06 Marks)**

5 a. What do you understand by phase and reaction equilibrium? Deduce the criterion for a equilibrium for chemical reaction taking place under constant pressure. **(10 Marks)**

b. Explain the transport properties of substance and their significance. **(10 Marks)**

6 a. Explain the terms rate of reaction, order of reaction, molecularity, half life and zero order reaction. **(10 Marks)**

b. Explain in brief the theories of laminar flame propagation. **(10 Marks)**

7 a. What are the different methods of measuring burning velocity? Explain flat flame burner method. **(10 Marks)**

b. Define turbulent burning velocity. Explain briefly the factors affecting turbulent burning velocity. **(10 Marks)**

8 Write short notes on the following :

a. Characteristic stability diagram for open flames

b. Combustion of a fuel droplet

c. Over feed stokers

d. Gas turbine combustion chamber. **(20 Marks)**

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